A delphinoid ear bone from the Dam Formation (Miocene) of Saudi Arabia

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Synopsis

A right periotic of a dolphin-like cetacean was found in near-shore marine rocks of Burdigalian age in eastern Saudi Arabia. Its resemblance to ear bones of primitive Delphinidae suggests that a primitive delphinid, or an advanced kentriodontid, lived in the Tethys epicontinental sea in Burdigalian times.

Introduction

A single delphinoid ear bone was collected by P. J. Whybrow in 1979 from the type locality of the Dam Formation at Jabal Lidam, 26° 21′ 42″ N, 49° 27′ 42″ E, eastern Saudi Arabia. It is the first cetacean fossil to be reported from Saudi Arabia. Fragmented ribs of sirenians were also found at the locality.

Systematic palaeontology

Order **CETACEA** Brisson, 1762

Suborder **ODONTOCETI** Flower, 1867

Superfamily **DELPHINOIDEA** Flower, 1864

Delphinoidea, gen. et sp. indet.
Fig. 53

MATERIAL. A right periotic, M.42836.

DESCRIPTION. Among the holdings of the United States National Museum of Natural History (USNM 258859), a periotic of the living species *Sousa chinensis* Osbeck 1765 from the Gulf of Siam, is most similar to the fossil. The pars cochlearis is similarly prominent (transverse measurement from apex of pars cochlearis to posterior border of anterior process = 20·2 mm in M.42836 and 21·2 mm in USNM 258859), although in the fossil, its dorsal side is slightly more bulbous than in *S. chinensis*. In both the fossil and *S. chinensis*, the foramen singulare and the internal aperture of the Fallopian aqueduct are included in the depression of the internal auditory meatus (Fig. 53a); this depression is slit-like, is widest in the area of the internal auditory meatus, and is orientated at an angle of about 45° to the transverse axis of the pars cochlearis. It is separated from the triangular hollow surrounding the opening of the endolymphatic duct by a keel on its lateral margin (see Kasuya 1973: 34, fig. 65).

In both the fossil and *S. chinensis*, the anterior process is only slightly elongated, is turned only slightly in a medial direction, and has a rectangular end (Fig. 53b); the posterior process, seen laterally (Fig. 53c), is in the same plane as the anterior process; its articular surface in both specimens bears fine grooves where it was attached to the tympanic (Fig. 53b). The fossil periotic is 28·75 mm long; its pars cochlearis is 16·2 mm long at the base. The ratio between these measurements reflects the shortness of the anterior and posterior processes. In both specimens, the superior process is divided into lateral and dorsal planes by a longitudinal keel.

Barnes (1978) raised the Kentriodontinae of Slijper 1936, a subfamily of the Delphinidae, to family rank as the Kentriodontidae, a family of middle and late Miocene delphinoid cetaceans which are more primitive than the Delphinidae. The Arabian specimen differs from the periotics of species of Kentriodontidae in having derived characters typical of Delphinidae. It differs from *Kentriodon*, *Liolithax kernensis* Kellogg 1931, and *Delphinodon dividum* True 1912 in

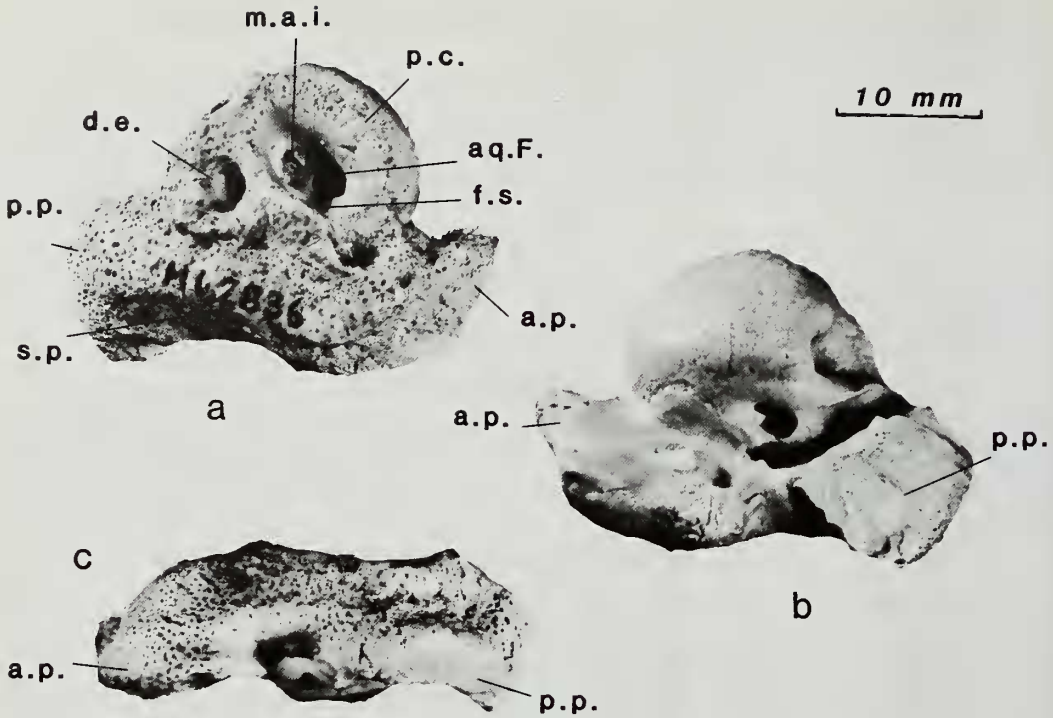

Fig. 53 Delphinoidea, genus and species indeterminate. Right periotic, BM(NH) M.42836. a, cerebral (dorsal) view; b, ventral view; c, lateral view. × 2. Key: a.p., anterior process; aq.F., opening of Fallopian aqueduct; d.e., opening of endolymphatic duct; f.s., foramen singulare; m.a.i., internal auditory meatus; p.c., pars cochlearis; p.p., posterior process; s.p., superior process. From Dam Formation, Jabal Lidam, Saudi Arabia. Burdigalian.

having the anterior and posterior processes in the same horizontal plane, and in having a flat superior process, grooved articular surface of the posterior process, and relatively short anterior process. From *Liolithax pappus* (Kellogg 1955) it differs in having a relatively short anterior process and relatively larger pars cochlearis. It differs from *Kentriodon*, *Lophocetus calvertensis* (Harlan 1842), and *Delphinodon dividum* in having a slit-like depression for the internal auditory meatus, which also contains the foramen singulare and the internal aperture of the Fallopian aqueduct. The Arabian specimen was also compared with a periotic from Lee Creek, North Carolina (USNM 183001), probably from the Pungo River Formation (early and middle Miocene), that was identified by L. G. Barnes (oral communication, September 17, 1975) as identical to the periotics accompanying a skull of *Pithanodelphis* from the late Miocene of California. In the shape of its anterior and posterior processes, this *Pithanodelphis* specimen closely resembles the Arabian specimen and the periotics of Delphinidae; however, its pars cochlearis is smaller than that of the Arabian periotic.

The Arabian specimen also closely resembles a periotic (USNM 317874) of an undescribed ondontocete from the Pungo River Formation of North Carolina. The major difference between the two specimens is that the periotic from North Carolina has a smaller pars cochlearis.

Although they are smaller, two unidentified periotics (UCMP 88582 and UCMP 88583) from the San Diego Formation (Pliocene) of California resemble the Arabian specimen in the slit-like internal auditory meatus, in the shape of the pars cochlearis and anterior process, and in the articular surface of the posterior process being in the same plane as the anterior process (see Barnes 1973: fig. 2g–j).

Discussion

The single cetacean periotic from the Dam Formation possesses characters typical of primitive Delphinidae, and possibly of advanced Kentriodontidae. Its morphology is closest to that of the living genus *Sousa*, the humpbacked dolphin, now living in coastal waters and the mouths of rivers from the South China Sea west through the Straits of Malacca, the Bay of Bengal, and the Arabian and Red Seas to the Suez Canal, and in waters off South Africa and west Africa (Hershkovitz 1966: 18–25). However, definite generic assignment can be made only in the basis of the skull. The only conclusion that can be reached from study of a single ear bone is that a possible close relative of *Sousa* is present in the Dam Formation. *Sousa* itself has never been reported as a fossil.

Remington Kellogg, in a letter to D. W. Rice (December 4, 1962: Smithsonian Institution Archives, Record Unit 88, Box 6), pointed out the resemblance between the periotics of the Miocene genus *Kentriodon* and the living New World freshwater porpoise *Sotalia*. He wrote:

> The fresh water porpoises of the genus *Sotalia* all possess periotic bones with similar characteristics. If you will refer to the following article . . . [Kellogg 1927] . . . you will find illustrations . . . [pl. 3, figs 2–4] . . . of this fossil porpoise which resemble those of *Sotalia* rather closely. The configuration of the cerebral surface and the shape of the internal acoustic meatus is similar in both. *Kentriodon* which was present in the Miocene period in the Chesapeake embayment may have been an antecedent of the fresh water porpoise *Sotalia*. . . .
>
> Dr Fraser and I have not come as yet to any final conclusion as to the family allocation of *Sotalia*. Relatively few specimens have been received by museums. On the basis of present information it would appear that *Sotalia* may possibly be somewhat closely related to *Steno* and *Sousa*, but in my opinion this allocation should be deferred until more adequate information is available.

The family Kentriodontidae, as defined by Barnes (1978), reflects a middle to late Miocene delphinoid radiation of animals that were more primitive than, but in part contemporaneous with, members of the more advanced family Delphinidae. True (1912) favourably compared *Delphinodon dividum* True 1912 with *Pithanodelphis* Abel 1905 of the Miocene, and with living *Steno* and *Sotalia*. Barnes (1978) placed *Delphinodon* and *Pithanodelphis* with *Kentriodon* in the Kentriodontidae; I include *Sousa* with *Steno* and *Sotalia* as structurally primitive living Delphinidae.

The periotic from the Dam Formation is delphinoid in that the articular surface for the bulla on the posterior process is in the same horizontal plane as the ventral side of the anterior process and, concomitant with this, the superior process is low and flat. The Arabian periotic has a longer, straighter anterior process than do those of advanced Delphinidae, whose anterior process is directed medially and is partly appressed against the anterior side of the pars cochlearis. This combination of characters is probably a morphological stage between the relatively primitive periotics of the Kentriodontidae and the derived condition in the Delphinidae.

If the Arabian periotic is accepted as representing a species in the Delphinidae, this record extends the range of the Delphinidae farther back in time than has previously been reported. Barnes (1976: 330, tab. 4; fig. 2) reported a late Miocene species of Delphinidae *sensu stricto*, known from a complete skull from California. This specimen is at least ten million years old, but even this is at least five million years younger than the specimen from the Dam Formation. On the slim evidence that we have, familial assignment of the Arabian periotic to the Delphinidae or to the Kentriodontidae must await collection of more material.

Tethyan Distribution of Miocene Delphinoidea

In Burdigalian time the area that is now eastern Saudi Arabia was separated from the ancestral Mediterranean by an evaporite realm that formed a land bridge between Asia and Africa (Steininger *et al.* 1985). Earlier in the Miocene the land area was occupied by a strait allowing access by its marine fauna to the western Tethys. The marine mammal fauna represented by the specimen from the Dam Formation could, therefore, have been related to forms from farther

west in the Tethys Sea. Unfortunately, only one penecontemporary delphinoid, '*Delphinus*' *vanzelleri* Fourtau 1918, is known from the Mediterranean Tethys. This species, represented only by a partial jaw from the Lower Miocene Moghara Formation of Egypt, is probably generically unidentifiable (Barnes & Mitchell 1978) and cannot be compared to the Saudi Arabian specimen.

Five genera of Delphinoidea are known from the late Miocene (Sarmatian) of the Caucasus. Three of these, *Leptodelphis* Kirpichnikov 1954, *Sarmatodelphis* Kirpichnikov 1954, and *Microphocaena* Kudrin & Tatarinov 1965, have been placed in the Kentriodontidae by Barnes (1978). The other two, *Anacharsis* Bogachev 1956 and *Imerodelphis* Mchedlidze 1959, are tentatively assigned to the Delphinidae. These genera have not been identified elsewhere, and it is possible that they were endemic to Paratethys.

The resemblance, pointed out above, of the Saudi Arabian specimen to isolated periotics from North Carolina and California may indicate distribution of related Delphinoidea throughout the Tethys in Miocene time.

Conclusions

A primitive delphinoid, similar to and perhaps related to *Sousa*, was present in the ancestral Arabian Gulf in Burdigalian time. Confirmation of the taxonomic position of this cetacean must await collection of more material from the Dam Formation. Despite this taxonomic uncertainty, the morphology of the periotic makes it clear that we have here another bit of evidence of the radiation of the earliest modernized dolphins. Similar bones (unfortunately usually unaccompanied by skulls) from the middle Miocene to lower Pliocene of North Carolina may indicate a Tethyan distribution of related primitive delphinoids. A continuous range of these forms from the Tethys to the west coast of North America would have been possible because of the existence of the Panama seaway (see Whitmore & Stewart 1965).

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